California Department of Public Health
Marine Biotoxin Monitoring Program

2019 Annual Mussel Quarantine

BACKGROUND INFORMATION

This information is provided for the preparation of press releases, answering inquiries from the public, and other purposes related to shellfish poisoning and the annual mussel quarantine. Questions and requests for additional information may be directed to the California Department of Public Health (CDPH), Environmental Management Branch [Vanessa Zubkousky-White, Coordinator, Biotoxin Monitoring Program, at (510) 412-4635, or Dr. Duc Vugia of the Infectious Disease Branch, at (510) 620-3434].

Introduction

The annual quarantine on sport-harvested mussels is normally in effect from May 1 through October 31. Occasionally the annual quarantine will begin sooner than May 1 due to significant increases in toxin levels earlier in the year. Similarly, a biotoxin event may persist beyond the end of October, resulting in an extension of the annual quarantine for one or more counties. The annual mussel quarantine applies to the entire coastline of California, including all bays, inlets, and harbors. The main purpose of the quarantine is to protect the public from the toxins that cause paralytic shellfish poisoning (PSP) and amnesic shellfish poisoning (ASP). Both of these syndromes are associated with consumption of bivalve (two-shelled) mollusks, such as mussels, clams, cockles, oysters, and scallops, which feed by filtering tiny particles from the water. Domoic acid, the toxin responsible for ASP, has also been found at levels of concern in the viscera and flesh of crustaceans like crab and small finfish like anchovies and sardines.

The mussel quarantine restrictions and recommendations apply only to shellfish collected by sport harvesters. Mussels and other bivalve mollusks harvested by state-certified shellfish growers and sold commercially in markets and restaurants should pose no risk of poisoning to consumers as they are closely monitored and tested. Since the PSP outbreak in 1980 included illnesses from consumption of commercially harvested oysters; commercial shellfish producers have been required to submit specimens weekly from all commercial harvest areas for PSP assay by CDPH. Bivalve mollusks imported into California are similarly monitored for biotoxins by the producer states.

Shellfish toxin levels do not rise and fall in predictable cycles and can increase rapidly. Prevention of human illnesses requires strict enforcement of the annual quarantine, combined with year-round surveillance, public education, occasional special health advisories and commercial closures as needed.

Paralytic Shellfish Poisoning (PSP)

The Ecology of PSP

The source of the PSP toxins in bivalve mollusks is a dinoflagellate known as *Alexandrium catenella*. Unfortunately, unlike some parts of the world where visible blooms of *Alexandrium* occur, it is highly unusual to experience a 'red tide' of this dinoflagellate along the California coast. Because the PSP toxins produced by *Alexandrium* are so potent, it takes very few cells in the water to create a public health risk from shellfish consumption. Therefore visual cues of ocean color are not reliable indicators of safe or unsafe conditions for shellfish harvesting and consumption. Shellfish can develop extremely hazardous levels of toxin within a few days without any visible warning. Conversely, the majority of red tides observed along the California coast are associated with nontoxic species of dinoflagellates.

In California, PSP occurs most commonly during the warm spring, summer, and early fall months, although episodes of high toxicity in shellfish have occurred during the winter months also. PSP was made a reportable disease in 1927. There is some limited information about cases prior to 1927 although there could be underreporting during this time. Since 1903, 582 total cases including 543 illnesses and 39 deaths have been attributed to PSP in California. Over 99 percent of these cases have occurred during the months of May through October. The last major PSP outbreak in California occurred in July 1980 with 98 cases and 2 deaths. In August 1991, 11 non-fatal cases, including 3 that were hospitalized, were reported in persons who had eaten mussels they had collected in northern Sonoma County. In March 2018, 1 non-fatal case including hospitalization was reported in a person who ate mussels collected in northern Marin County. Elevated levels of the PSP toxins have historically been detected in mussels, oysters, scallop viscera, clams, abalone jingles, and gooseneck barnacles. Red abalone, crab, and shrimp have not been the source of any cases of PSP in California, although the latter two crustaceans could potentially accumulate PSP toxins in the internal organs.

PSP in January through April 2019

Between January and April 2019, measurable concentrations of PSP toxins have been detected every month and in a total of 33 shellfish samples from the following coastal counties: Del Norte, Humboldt, Mendocino, Sonoma, Marin, San Mateo, Santa Cruz, Monterey, and Santa Barbara. A mussel sample collected April 24 at the Santa Cruz Pier contained 235 µg/100 g PSP toxins, over the alert level (80 µg/100 g of tissue). Elevated levels of PSP toxins were also detected in samples of scallop viscera from Monterey Commercial Wharf.

PSP in 2018

Alexandrium was observed at sites along most coastal counties during 2018. This dinoflagellate was observed during all months in 2018 and it occurred at multiple sites along the California coast sporadically throughout the year. The highest percent

composition was in March at Pacifica Pier in San Mateo County. Elevated percent composition and frequency of occurrence was in January through March at multiple sites in Marin, San Francisco, San Mateo, Monterey, and San Luis Obispo counties.

An unusually large PSP event occurred in early 2018 spanning from Sonoma County to Santa Barbara County. A PSP toxin concentration greater than or equal to the alert level (80 µg/100 g of tissue) was first detected in a mussel sample from San Luis Obispo County on January 29. The toxin was then detected in multiple counties over the next few months. The initial detection of elevated PSP toxins in mussel samples from subsequent counties occurred in February from Monterey, Marin and San Mateo counties, in March from Sonoma, San Francisco, Alameda, Contra Costa and Santa Cruz counties, and in April from Santa Barbara County. Elevated levels of PSP toxins were also detected in samples of scallop viscera, oysters, and clams during this event.

Measurable concentrations of PSP toxins were found in 214 shellfish samples from the following coastal counties: Del Norte, Humboldt, Mendocino, Sonoma, Marin, Contra Costa, Alameda, San Francisco, San Mateo, Santa Cruz, Monterey, San Luis Obispo, Santa Barbara, Ventura, and Los Angeles. Detection of measurable PSP toxins occurred during every month of 2018. Concentrations of PSP toxins greater than or equal to the alert level (80 µg/100 g of tissue) were detected in samples from Sonoma, Marin, Contra Costa, Alameda, San Francisco, San Mateo, Santa Cruz, Monterey, San Luis Obispo, Santa Barbara, and Ventura counties. The highest concentrations detected were in mussel samples; 4,760 µg/100 g PSP toxins collected March 19 at Chimney Rock in Marin County and 4,672 µg/100 g collected March 15 at Bodega Bay in Sonoma County.

Domoic Acid

The Ecology of Domoic Acid

Domoic acid was first recognized as a cause of poisoning in humans in an outbreak in Canada in 1987, when approximately 150 persons became ill and four died after consuming toxic mussels from Prince Edward Island on the Canadian Atlantic coast. The source of the domoic acid in this outbreak was a diatom known as *Pseudo-nitzschia pungens* forma *multiseries*. This single-celled marine algae, like dinoflagellates, is a natural food source for filter-feeding animals.

The first documented occurrence of domoic acid on the Pacific Coast of the United States was in September and October 1991 in the vicinity of Santa Cruz, on Monterey Bay. In this episode it was found to be the cause of death of several hundred brown pelicans and Brandt's cormorants. The birds were exposed to domoic acid by feeding on anchovies, which had fed on a bloom of the diatom *Pseudo-nitzschia australis*. Prior to the 1991 event, there is evidence that *Pseudo-nitzschia* was abundant in Monterey Bay in 1961 during a sooty shearwater die off, inspiring Hitchcock's film *The Birds.*

Subsequent sampling revealed elevated concentrations of domoic acid in mussels at

several locations around Monterey Bay, and elevated levels also were found in razor clams sampled in Humboldt and Del Norte Counties. Low concentrations of domoic acid have subsequently been found in mussels from almost every coastal county in California. The high levels of domoic acid in Monterey Bay coincided with a bloom of the diatom *Pseudo-nitzschia australis*, and the toxin also was found in plankton samples containing mostly this diatom species.

Similar domoic acid events occurred in May 1998, the summer of 2000, and the spring of 2015 along the San Luis Obispo County coast and in Monterey Bay. These events involved illness or death in large numbers of California sea lions and, as in 1991, anchovies and sardines again appeared to be responsible for providing a pathway for toxin transport from the diatoms to the marine mammals. Volunteer phytoplankton observers were instrumental in CDPH's ability to detect and track these blooms. Intensive sampling of a variety of seafood species determined that high concentrations of domoic acid could be found in a number of bivalve shellfish, like mussels and oysters, as well as in the digestive gland of crabs, spiny lobsters, sardines and anchovies. Persistent elevated levels of domoic acid have been detected in razor clam meat from Humboldt and Del Norte counties since 2015. Domoic acid also has been found in Oregon and Washington in razor clams, mussels, and crabs.

The seasonal pattern of occurrence of *Pseudo-nitzschia* and domoic acid has changed significantly since monitoring began in 1991. The initial event in Monterey Bay occurred in the fall and phytoplankton monitoring in the years immediately following this event confirmed this seasonal pattern of increase in *Pseudo-nitzschia*. There was very little domoic acid toxicity detected through the remainder of the 90's, although there was a large scale marine mammal mortality event due to domoic acid in 1998 as noted above. During 2000 there was a noticeable increase in domoic acid activity in Monterey Bay and along the San Luis Obispo County coast during the summer months, extending into November at some locations. In 2002 there was an early spring increase in *Pseudo-nitzschia* and domoic acid concentrations. This event began in Monterey Bay in February and appeared to 'move' down the coast between San Luis Obispo and Los Angeles Counties through June. This spring bloom pattern persisted through most of the remainder of the decade, although a smaller fall event occurred in 2009 and a winter event occurred in Santa Barbara County in 2011. In 2015, domoic acid was detected in shellfish from Del Norte County to Los Angeles County when a large bloom of *Pseudo-nitzschia* persisted off the west coast of North America from California to Alaska. In 2017 domoic acid was again detected over a large range of the coast with elevated levels in mussels from Del Norte, Monterey, Santa Barbara, Ventura, and Los Angeles counties. The changing seasonality and distribution of *Pseudo-nitzschia*, and subsequently of domoic acid concentrations in seafood, reinforces the need for a rigorous monitoring program throughout the year to ensure public health protection.

Domoic acid poisoning in humans has not been reported in California. Extensive phytoplankton sampling is being conducted to investigate the spatial and temporal distribution of the diatoms associated with domoic acid production. Extensive blooms of the diatoms that produce domoic acid have been detected and followed along most

coastal counties since this program began.

These environmental observations provide an early warning to potentially toxic blooms, allowing CDPH to respond quickly with intensified sampling and toxin analysis in the affected area.

Domoic Acid in 2018

Pseudo-nitzschia was observed at sites along all coastal counties during 2018. This diatom was observed during every month in 2018. The highest percent composition occurred in June at San Simeon Pier in San Luis Obispo County. Elevated percent composition and frequency of occurrence was in February through September, at sites in multiple counties, including Del Norte, Humboldt, Sonoma, San Mateo, Santa Cruz, San Luis Obispo, and Los Angeles.

Measurable concentrations of domoic acid were found in 21 shellfish samples, not including 113 razor clam samples, from the following coastal counties between April and November: Del Norte, Humboldt, Sonoma and Marin. Razor clam samples from Del Norte and Humboldt Counties had measurable concentrations of domoic acid throughout 2018. Concentrations of domoic acid above the alert level (20 µg/g of shellfish meat, or 20 parts per million [ppm]) reached 300 ppm in razor clams from Humboldt County and 87 ppm in mussels from Humboldt County.

More information on crab monitoring data from 2018 and associated health advisories is available at the following link:
https://www.cdph.ca.gov/Programs/CEH/DFDCS/Pages/FDBPrograms/FoodSafetyProgram/DomoicAcid.aspx

Special Risks from Various Kinds of Seafood

The greatest hazard for PSP and domoic acid poisoning is from the consumption of mussels (see also discussion below on razor clams) because: (1) they concentrate the toxins more quickly and to higher levels than do other shellfish, (2) they generally occur along the open coast where they are directly affected by oceanic blooms, and (3) they are eaten whole without removal of digestive organs. The digestive organs of crustaceans such as lobster and crab, as well as of small finfish like sardine and anchovy, can also contain dangerous levels of domoic acid, as can the flesh. Other contaminants can also be concentrated in the viscera, so the public is advised to avoid consuming the internal organs of any seafood species.

The consumer cannot distinguish toxic mussels from harmless ones. Moreover, cooking cannot be relied upon to destroy the toxins because they are relatively heat stable. The safest guideline for consumers is: Do not eat mussels taken by recreational sport-harvesters from California coastal waters during the annual quarantine months of May through October. During other months, call the CDPH "Biotoxin Information Line" at 1-800-553-4133 for an up-to-date, recorded message of any special health advisories.

While clams can develop hazardous levels of PSP toxin, they are placed under quarantine only in localized areas when tests reveal the presence of elevated toxin levels in mussels in the vicinity of clam beds or in clams themselves. In clams, the toxin is concentrated primarily in the digestive organs (dark meat), hence, these portions from all types of clams should always be discarded; only the white meat should be eaten.

A special hazard is presented by the Washington or butter clam (*Saxidomus* spp.). They may concentrate the PSP toxins in the neck or siphon (the tube-like part of the clam that sticks out between the shells). It has been found that PSP toxin in the necks of Washington clams may persist for a year or more after an outbreak of PSP.

Northern razor clams (*Siliqua patula*) have been found to present a special risk for domoic acid poisoning because they concentrate this toxin in the white meat of the foot and siphon, parts that normally are preferred for human consumption. Razor clams are able to retain this toxin for extended periods, just as the Washington clam retains the PSP toxins.

Scallops from California waters may also become toxic. This is true for both the adductor muscles (the "scallop" or white meat that is ordinarily eaten) and the digestive organs (the darkish soft tissue of a scallop left after the white adductor muscle has been removed). In August 1980, a man died of PSP after eating only the digestive organs of a single rock scallop (*Hinnites giganteus*) taken by a sport-diver on the Sonoma County coast. Subsequent investigations revealed that a lower, but still hazardous, concentration of the toxin also may occur in scallop adductor muscles during a PSP episode. The digestive organs of scallops should never be eaten as they may remain toxic year-round. It is unknown how long PSP toxins may persist in the white meat of scallop adductor muscles.

Symptoms of PSP

Acute symptoms of PSP poisoning can occur within a few minutes to a few hours of consumption. Symptoms begin with tingling and numbness of the lips, tongue, and fingertips, followed by disturbed balance, lack of muscular coordination, slurred speech, and difficulty in swallowing. In severe poisoning, complete muscular paralysis and death from asphyxiation can occur if breathing is not maintained by artificial means. There is no known antidote to the poison. Symptoms tend to resolve entirely in a day or two under proper medical care. Persons who suspect they or others are experiencing PSP symptoms should immediately seek medical treatment.

Symptoms of Domoic Acid Poisoning

Symptoms of domoic acid poisoning can occur within 30 minutes to 24 hours after eating toxic seafood. In mild cases, symptoms may include vomiting, diarrhea, abdominal cramps, headache, and dizziness. These symptoms disappear completely within several days. In severe cases, the victim may experience excessive bronchial secretions, difficulty breathing, confusion, disorientation, cardiovascular instability, seizures,

permanent loss of short-term memory, coma, and death. When memory is lost, victims can remember things they knew before they became ill, but remember little that happened after. As with PSP, there is no known antidote and persons experiencing symptoms should receive immediate medical attention.

Groups at Special Risk of Shellfish Poisoning

A disproportionate number of PSP cases have occurred in two broad ethnic groups. These include persons from the Philippine community and immigrants from Southeast Asia. The high incidence in these two groups probably can be explained by their cultural penchant for mussels and other shellfish as a dietary item, and by their unfamiliarity with the PSP problem.

Reporting of Suspected PSP in Humans

PSP and domoic acid poisoning are reportable as food poisoning (Title 17, California Code of Regulations, Sections 2500 and 2574). Even suspected cases should be reported immediately by telephone to the local health department and to the nearest poison control center. Local health departments report PSP cases immediately to the CDPH Infectious Disease Branch.

Infectious Disease Hazards

Bivalve shellfish should never be taken from waters contaminated by sewage or other pollutants because they also can concentrate disease-producing bacteria and enteroviruses, such as Hepatitis A virus, in their digestive organs.

Public Information Available

CDPH has developed a “Frequently Asked Questions” (FAQ) for the annual mussel quarantine that can be found online at:
https://www.cdph.ca.gov/Programs/CEH/DRSEM/Pages/EMB/Shellfish/Annual-Mussel-Quarantine.aspx

The EMB maintains a toll-free "Biotoxin Information Line" with recorded updates on shellfish biotoxins and quarantines at 1-800-553-4133.

An information leaflet entitled "Natural Marine Toxins" is produced by CDPH and the University of California Cooperative Extension. This leaflet is available at the following web site:
https://www.cdph.ca.gov/Programs/CEH/DRSEM/CDPH%20Document%20Library/EMB/Shellfish/Natural_Marine_Toxins.pdf

Press releases are prepared by CDPH to announce the annual mussel quarantine and any health advisories issued. These can be found online at:
https://www.cdph.ca.gov/Programs/OPA/Pages/Shellfish-Advisories.aspx

Monthly reports issued by CDPH are available that include summary information and maps of PSP toxicity and toxigenic phytoplankton distributions along the coast. The monthly and annual reports can be found online at: https://www.cdph.ca.gov/Programs/CEH/DRSEM/Pages/EMB/Shellfish/Marine-Biotoxin-Monitoring-Program.aspx